

ONTOGENY OF TEETH ROW STRUCTURE IN *RANA TIGERINA* TADPOLES¹

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(With twelve text-figures)

A study on the ontogeny of labial teeth structure of Indian bull frog *Rana tigerina* was done by examining laboratory reared tadpoles. The teeth row formula was determined for every stage of development beginning with external gill stage and ending with both limb + tail stage. It is noted that the number of teeth rows on both upper and lower jaw reached a maximum of 5(2-5)/0/(1-3) at well developed hindlimb stage, but only one tadpole out of five in limb paddle with five toes was found with six rows in the lower jaw. It is interesting to note that there were variations in the rows of teeth even in the same stage of development. There was a decrease in the number of teeth rows from the beginning of the emergence of forelimb upto complete tail resorption. A comparison of the present study with that of Agarwal and Niazi (1977) has been made, and the variations in the teeth rows in different stages of development have been pointed out. The reason for this variation has also been discussed.

INTRODUCTION

The labial teeth are some of the most distinguishing features for identification of amphibian larvae. Workers like Campbell (1931), Taylor (1942), Wright and Wright (1949), Stebbins (1951 and 1954), Orton (1952), Zweifel (1955 and 1964), Bragg and Bragg (1959), Starret (1960), Altig (1970), Altig and Pace (1974), and Lee (1976) have reported on the teeth structure of the tadpoles of different species of frogs from temperate climate. Orton (1953 and 1957) has proposed a classification of frog families based upon the keratinized mouth parts. A detailed report on the internal oral

features of larvae from eight anuran families of U.S.A. has been described by Wassersug (1980). In a study on ontogeny he (Wassersug 1976) has also described the internal oral features of *Hyla regilla*. Webb and Korky (1977) while studying the variation in the tadpoles of frogs of *Rana tarahumarae* group in Western Mexico have described the teeth row formula of that species and have given a formula for teeth structure.

Our knowledge on the teeth structure of Tropical species of anuran is limited. So in the present study an attempt has been made to focus on the ontogeny of teeth structure in the Indian bull frog *Rana tigerina*. Workers like Annandale (1917), McCann (1932), Kirtisinghe (1957) and Agarwal and Niazi (1977) have reported about the teeth row structure of this species, but they have not described the teeth structure in detail. Their description is based on some specific stages. In the present observation the teeth row structure of *Rana*

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TABLE 1
LABIAL TEETH ROW FORMULA OF *Rana tigerina*

Stages	Number examined	Length of tadpole in mm. with the nos. examined within brackets.	Labial teeth row formula*
External gills	5	7.5(3),8(2)	Without teeth, but with beak.
One external gill	15	10.5(4),10(2)9.5 10.5,9.5,11 11,10.5 9,9.5 9	1/0/2(1) 1/0/2 1/0/2 1/0/2(1) 1/0/0
Operculum complete	10	11(3),11.5(3) 11.5(2) 9,9.5	1/0/2(1) 1/0/2 1/0/1
Feeding	5	10.5(3) 11(2)	2(2)/0/2 2(2)/0/3(1)
Pigmented pearshaped tail	12	20(2),19.5(2),21 19.5(2) 18(2) 15(2) 15	3(2-3)/0/3(1) 3(2-3)/0/3(1-2) 3(2-3)/0/2 2(2)/0/2 4(2-4)/0/3(1)
Limb bud	10	21.5(2),21(2) 22(2) 25(2) 24(2)	3(2-3)/0/4(1-2) 4(2-4)/0/4(1-2) 4(2-4)/0/4(1-3) 3(2-3)/0/4(1-3)
Limb paddle	5	29.5(3) 30(2)	4(2-4)/0/4(1-2) 4(2-4)/0/5(1-3)
Limb paddle with 5 toes	7	31(4) 32(2) 37	4(2-4)/0/4(1-2) 4(2-4)/0/5(1-4) 4(2-4)/0/6(1-5)
Hind limb	5	40(3),39.5(2)	4(2-4)/0/4(1-2)
Well Dev. hind limb	5	44(2) 46(3)	4(2-4)/0/5(1-3) 5(2-5)/0/5(1-3)
One fore-limb	5	48(2) 46(2) 47	3(1-3)/0/4(1-3) 3(1-3)/0/3(1-2) 3(1-3)/0/2(1)
Both limb + tail	10	46.5(2),47(2) 40(2) 33(2) 30(2)	3(1-3)/0/2(1) 3(1-3)/0/3(1-3) 2(1-2)/0/2(1-2) 3(1-3)/0/2(1-2)

* According to Webb and Korky (1977).

tigerina has been studied in different stages of their development.

MATERIALS AND METHODS

The tadpoles of different stages of development were obtained in the laboratory by the methods described earlier (Dutta and Mohanty-Hejmadi 1976 and Dutta 1979). They were fixed in 10% formaldehyde for observation of their teeth structure. The larval stages described by Dutta (1979) were examined by binocular microscope, and the structures were sketched. Dental formula was determined according to the methods recommended by Webb and Korky (1977). A comparative statement of the present study with the studies of Agarwal and Niazi (1977) has been made.

OBSERVATIONS

A study on the ontogeny of labial teeth structure of Indian bull frog *R. tigerina* indicates that the number of teeth rows change with the stage of the tadpole as expected. For each stage even there is individual variation as reported for other species. Therefore, the structure of labial teeth of several tadpoles for each critical stage was examined (Table 1). Agarwal and Niazi (1977) have also studied the teeth structure of some developmental stages of this species. Therefore, a comparison of the present observations with those reported by Agarwal and Niazi (1977) is also included here (Table 2).

In general, the horny beaks are visible for the first time when the external gills are well developed. The first traces of labial teeth appear at the stage when operculum is closed on one side. By the time the tadpoles reach metamorphic climax there is shedding of labial teeth.

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TABLE 2

COMPARATIVE ACCOUNT OF TEETH ROW STRUCTURE OF *R. tigerina* AS OBSERVED BY AGARWAL, NIAZI AND THE PRESENT STUDY

AGARWAL AND NIAZI (1977)	PRESENT STUDY
1. <i>External gills:</i> White beak	Black beak
2. <i>Operculum fold: One side closed:</i> One row on upper jaw One row on lower jaw	One in upper jaw 0 to 2 in the lower jaw
3. <i>Operculum fold complete:</i> One row on upper jaw Two rows on lower jaw	One in upper jaw One to two rows in lower jaw.
4. <i>Feeding stage:</i> Not observed	Two in upper jaw Two to three in lower jaw
5. <i>Pigmented tail stage:</i> Not observed	Two to four in upper jaw Two to three in lower jaw
6. <i>Limb bud:</i> Upper jaw 2(1) or 3(2-3) or 4(2-4) Lower jaw 2 or 3(1) or 4(1-2)	3(2-3) or 4(2-4) (None had two rows) Four rows with either 4(1-2) or 4(1-3). (Only 6 out of ten had the structure 4(1-2) observed by Agarwal and Niazi)
7. <i>Limb paddle:</i> Upper jaw 4(2-4) Lower jaw 4(1-2)	Upper jaw 4(2-4) Lower jaw 4(1-2) or 5(1-3)
8. <i>Limb paddle with 5 toes:</i> Upper jaw 5(2-5) Lower jaw 5(1-3) (Last two rows uninterrupted)	Upper jaw 4(2-4) Lower jaw 4(1-2) or 5(1-4) or 6(1-5) (Only the last row uninterrupted)
9. <i>With both limbs:</i> Same as for previous stage	Number of teeth rows reduced due to shedding.

External gill stage:

At external gill stage, the mouth of the tadpoles consisted of a pair of black horny beaks, consisting of an upper mandible with a median cusp and a lower mandible with a corresponding notch for the cusp. There were no horny teeth (Table 1, Fig. 1). By the time gills on one side were covered by the operculum horny teeth appeared and the teeth row

formula varied from tadpole to tadpole (Fig. 2A-E). The teeth row formula ranged from 1/0/2 to 1/0/0 in the 15 tadpoles examined. In some of the tadpoles the teeth rows were weakly developed (Fig. 2B, 2D, and 2E).

Operculum complete stage:

A total of ten tadpoles were examined for this stage. Among these two had a teeth for-

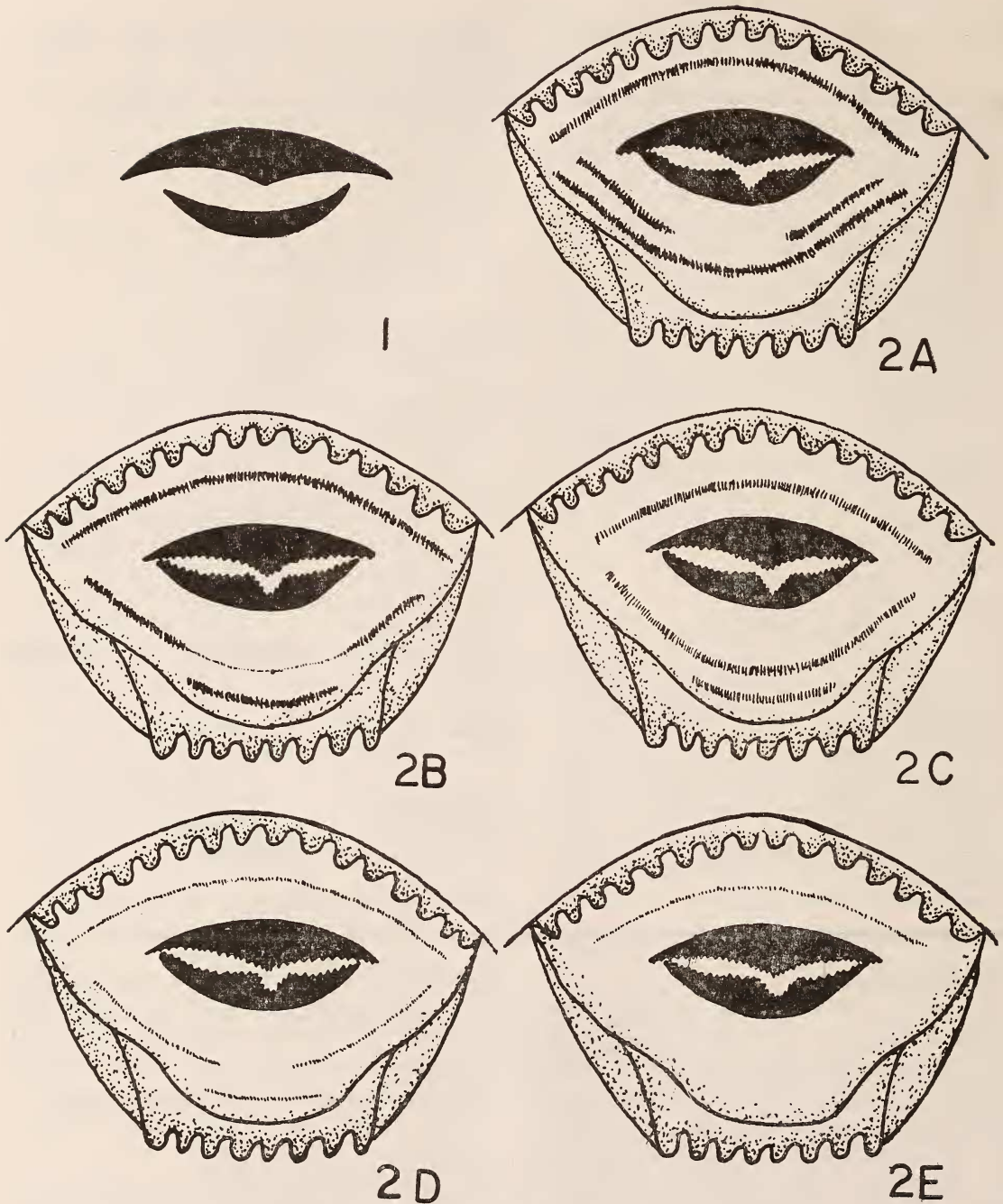


Fig. 1. External gill stage. Fig. 2A-E. One external gill covered stage.

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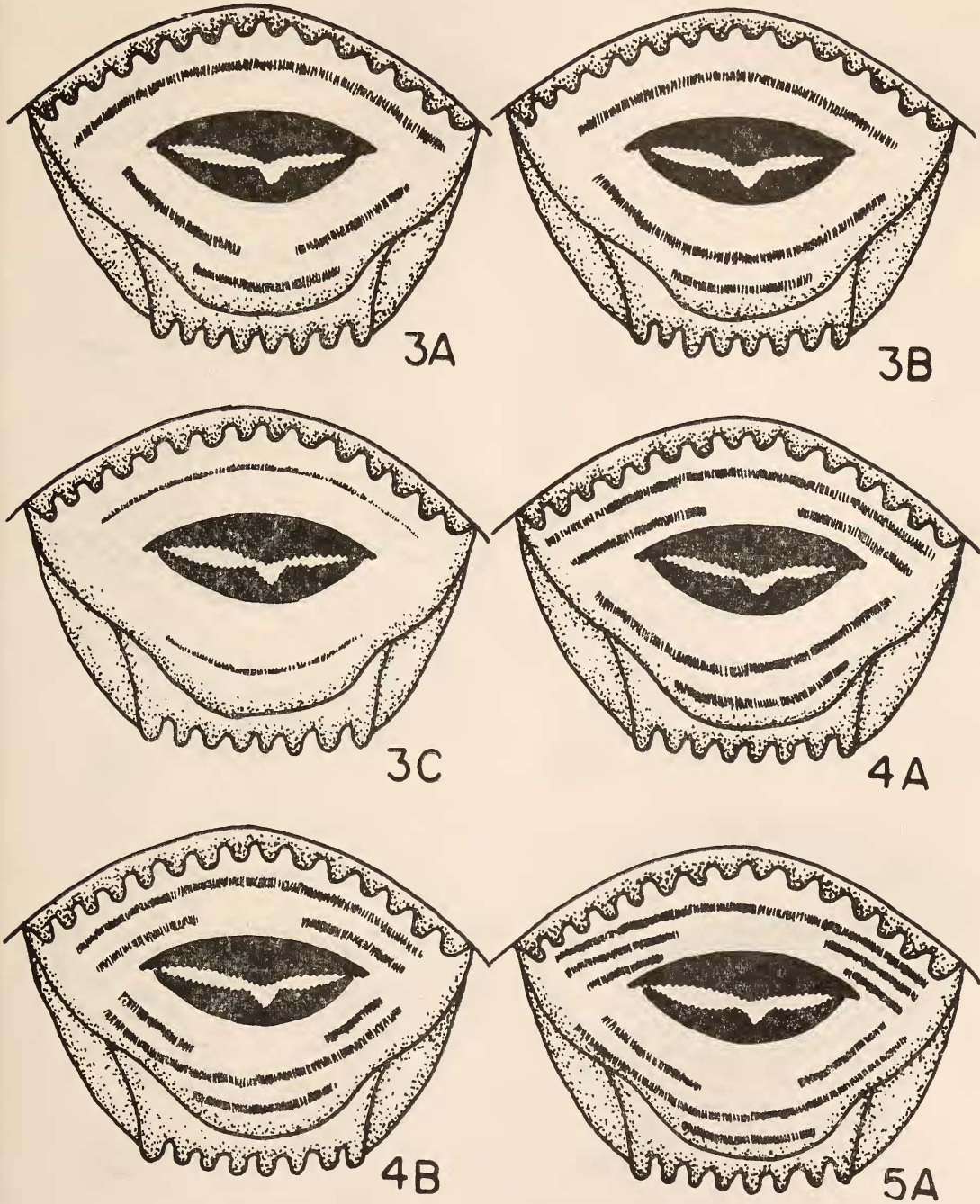


Fig. 3A-C. Operculum fold complete. Fig. 4A and 4B. Feeding stage.
Fig. 5-A. Pigmented pear shaped tail.

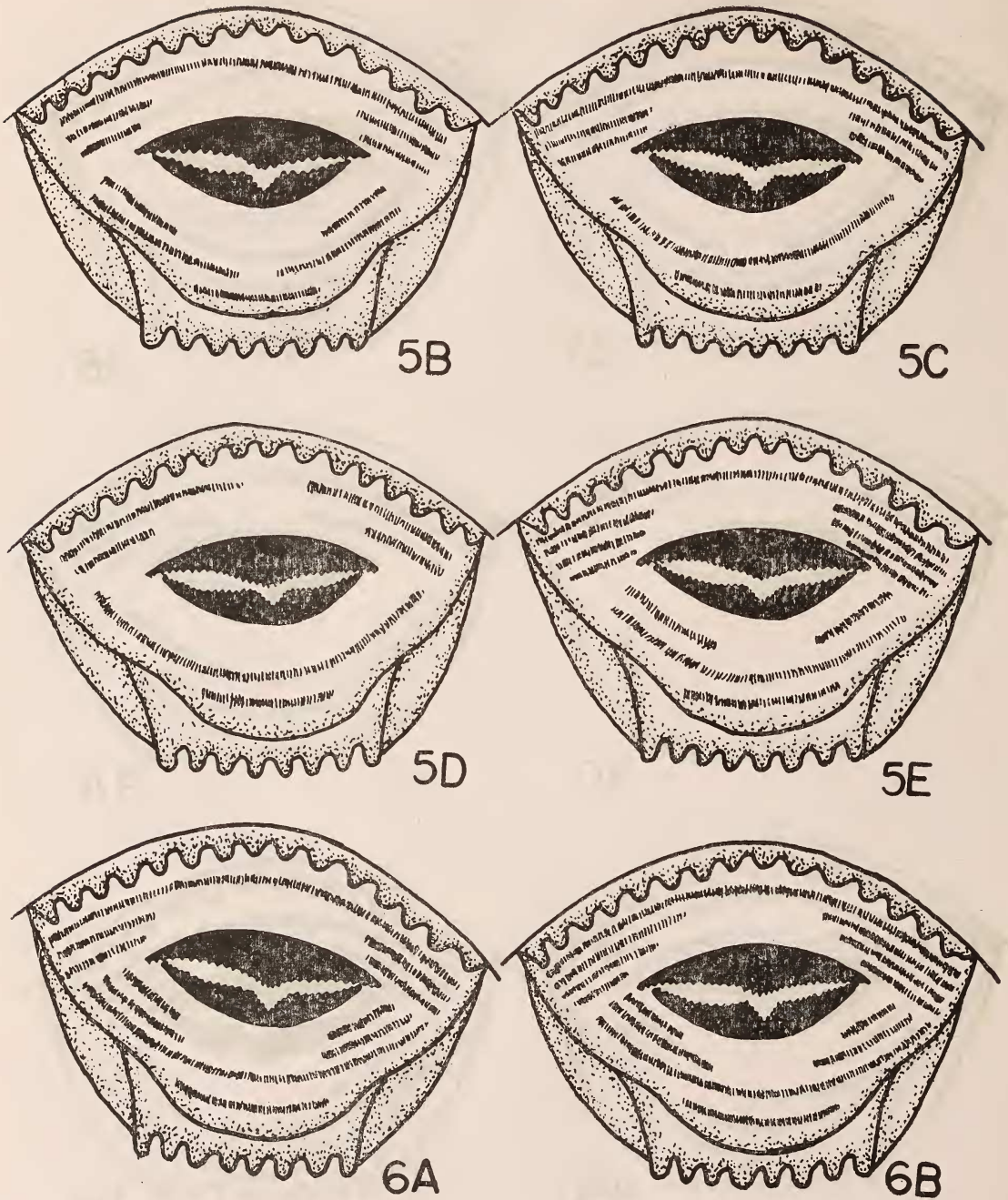


Fig. 5-B-E. Pigmented pear shaped tail. Fig. 6A-B. Limb bud stage.

mula of 1/0/1 (Fig. 3C), six had 1/0/2(1) (Fig. 3A) and two had 1/0/2 (Fig. 3B). From this it is evident that the teeth row in the upper jaw was constant but the rows on the lower jaw varied. In some cases teeth in the two jaws were weakly developed (Fig. 3C) like the previous stage. This was perhaps due to the smaller size of this particular tadpole.

Feeding stage:

At this stage a total of five tadpoles were examined. From them three were with a teeth row formula of 2(2)/0/2 and two with 2(2)/0/3(1). The teeth row on the upper jaw were constant, with the first one uninterrupted. In three tadpoles the two rows in the lower jaw were uninterrupted (Fig. 4A), but in other two tadpoles the first row in the lower jaw was interrupted and the second and the third rows were uninterrupted (Fig. 4B).

Pigmented tail stage:

The teeth row formula varied from 2(2)/0/2 to 4(2-4)/0/3(1) (Fig. 5A-E) in the twelve tadpoles examined. The number of teeth rows in the upper jaw varied from 2 to 4 out of which the first one was uninterrupted. Similarly the number of teeth rows varied from 2 to 3 in the lower jaw out of which the last row was uninterrupted.

Limb bud stage:

Out of ten tadpoles examined, four had a teeth row formula of 3 (2-3)/0/4(1-2) two with 4(2-4)/0/4(1-2), two with 4(2-4)/0/4(1-3) and two with 3(2-3)/0/4(1-3). This showed that the rows on the lower jaw were constant and the fourth row was uninterrupted in all the tadpoles but the teeth row on the upper jaw varied from 3 to 4 with the first one uninterrupted (Fig. 6A-D).

Limb paddle stage:

In this stage, three out of five examined had a teeth row formula of 4(2-4)/0/4(1-2) and other two with 4(2-4)/0/5(1-3). This showed that the teeth rows on the upper jaw of all the tadpoles were constant with the first one uninterrupted, while the rows in lower jaw varied from 4 to 5 with the last two rows uninterrupted (Fig. 7A and 7B).

Limb paddle with 5 toes:

At this stage of development four tadpoles had a teeth row formula of 4(2-4)/0/4(1-2), 2 with 4(2-4)/0/5(1-4) and one with 4(2-4)/0/6(1-5). So the rows of teeth on the upper jaw were constant with the first one uninterrupted but the number of rows on the lower jaw varied from 4 to 6 (Fig. 8A-C).

Hind limb stage:

Though this stage continued from initiation of limb paddle with five toes upto well developed hind limb stage yet the teeth structure was constant, that is 4(2-4)/0/4(1-2) in all the five tadpoles examined (Fig. 9). The first row on the upper jaw and the third and fourth row on the lower jaw were uninterrupted ones.

Well developed hind limb stage:

The number of labial teeth rows reached a maximum at this stage. Out of five tadpoles examined two had a teeth row formula of 4(2-4)/0/5(1-3) and other three with 5(2-5)/0/5(1-3), so the rows on the upper jaw varied with the first one uninterrupted while the rows in the lower jaw were constant (5) with the fourth and the fifth one uninterrupted (Fig. 10A and 10B).

One fore limb stage:

In all the five tadpoles examined the upper jaw had three interrupted rows of teeth, per-

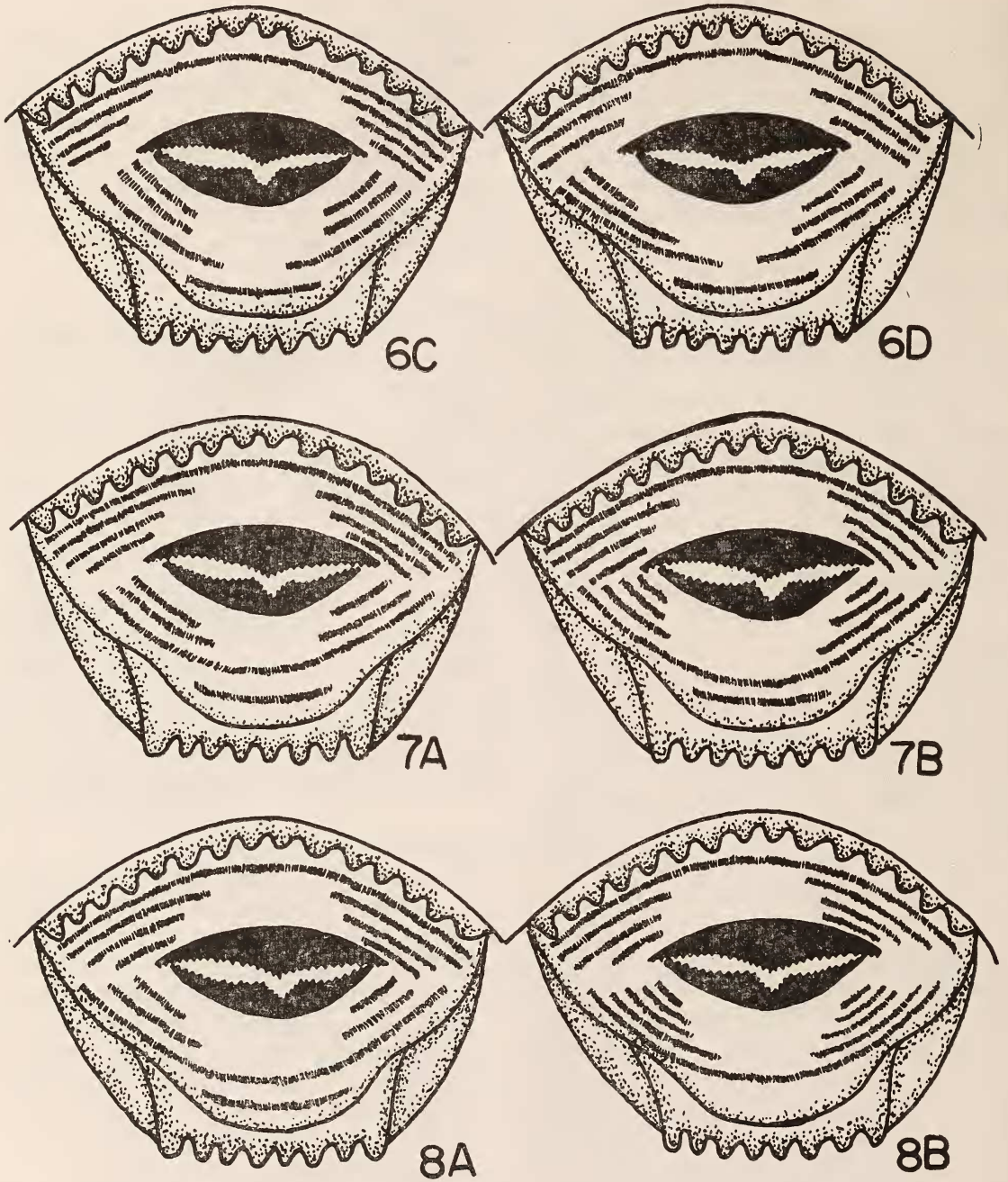


Fig. 6C-D. Limb bud stage. Fig. 7A and 7B. Limb paddle stage. Fig. 8A-B. Limb paddle with five toes.

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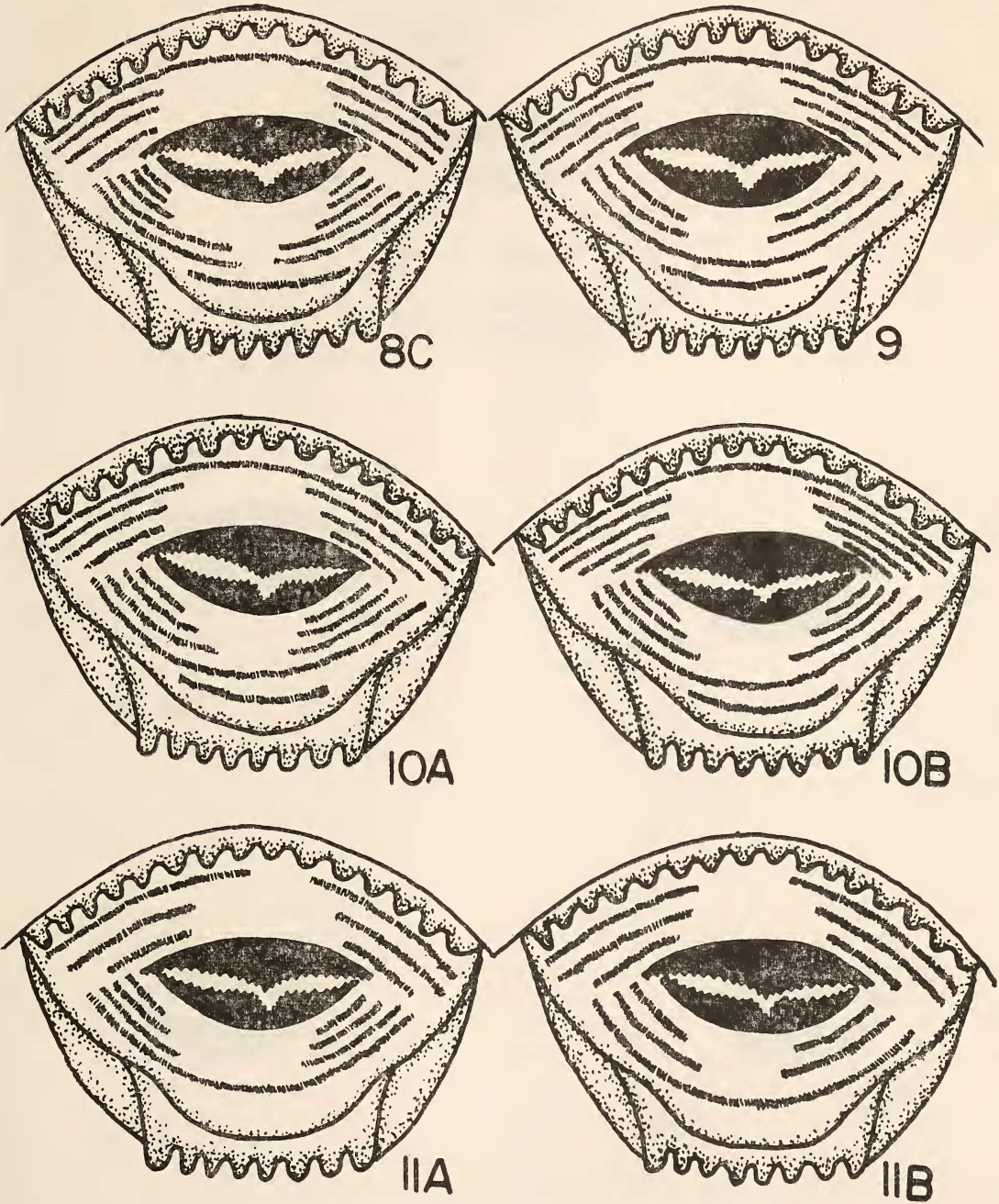


Fig. 8C. Limb paddle with five toes. Fig. 9. Hind limb stage. Fig. 10A and 10B. Well developed hind limb stage. Fig. 11A-B. One fore limb emerged stage.



Fig. 11C. One fore limb emerged stage. Fig. 12A-D. Both limb + tail.

haps because shedding of labial teeth had already started prior to metamorphosis. The rows on the lower jaw varied from 2 to 4 with the last one uninterrupted (Fig. 11A-C).

Both limb + tail:

At this stage more labial teeth were shed which is reflected in the teeth row formula $3(1-3)/0/2/(1)$, $3(1-3)/0/3(1-3)$, $3(1-3)|0|2(1-2)$ or $2(1-2)/0/2(1-2)$ for this stage (Fig. 12A-D). In all the tadpoles the rows on the upper jaw were interrupted. In six out of ten tadpoles all the rows in the lower jaw were also interrupted (Fig. 12 B-D).

DISCUSSION

There is considerable difference between the observation of this study and that of Agarwal and Niazi (1977). They have mentioned that during external gill stage there is a white beak. In all the earlier literature and in our study the beak was black. When the external gill became covered by the opercular fold on one side, one row of labial teeth in each jaw were observed by Agarwal and Niazi, but we noticed considerable individual variation as had been described earlier. Similarly for the rest of the stages there were individual variations. They had not reported on the teeth structure for feeding and pigmented tail stage. At limb bud stage also there are differences between their observations and the current study. Agarwal and Niazi (1977) reported that from their staging 41-50, the teeth structure remains constant. These stages range from the formation of fourth interdigital indentation to the emergence of fore limbs. However, in the current study considerable variation was seen during these stages. The number of rows reached a maximum when the limbs were well developed. Only three out of five well developed hind

limb stages in this study had mouth parts identical to that reported by Agarwal and Niazi (1977). By the time fore limbs appeared, none of the tadpoles examined by us retained the full compliment of teeth as reported by them. The major differences between their study and ours is presented in table 2.

The current study shows that as in the development of temperate anurans, there is ontogenic variation in labial teeth structure. As the number of teeth row structure change with development and even for the same stage of development, the stage of the larvae at which the teeth row formula is determined has to be clearly defined. We noticed that the last two rows of teeth from feeding stage till the beginning of metamorphosis remained uninterrupted. This is in agreement with the diagrams given by Annandale (1917) and McCann (1932). In contrast Kirtisinghe (1957) observed that only the lowermost row of teeth was uninterrupted. Since Kirtisinghe did not specify the populations he examined or the number of tadpoles, it is difficult to assess this difference. Agarwal (1978) and Agarwal and Niazi (1978) were the first to report the ontogeny of labial teeth according to the stage of tadpoles for *R. tigerina*. Since they did not mention the number of tadpoles observed for each stage, the differences could either be due to the lesser number of tadpoles examined by them or due to geographical variation. They examined populations from north India, and this study is based on the population of eastern India. It is possible that environmental factors may influence teeth structure of tadpoles.

Therefore, in this study systematic observation has been done on several individuals from each stage and a range of teeth structure is reported for each stage. This extends the work of earlier workers and provides the first systematic study on the ontogeny of teeth of

R. tigerina and for that matter on only one of several Indian species.

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